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"Radiation pressure on tunable optical metamaterials for propulsion and steering without moving parts"

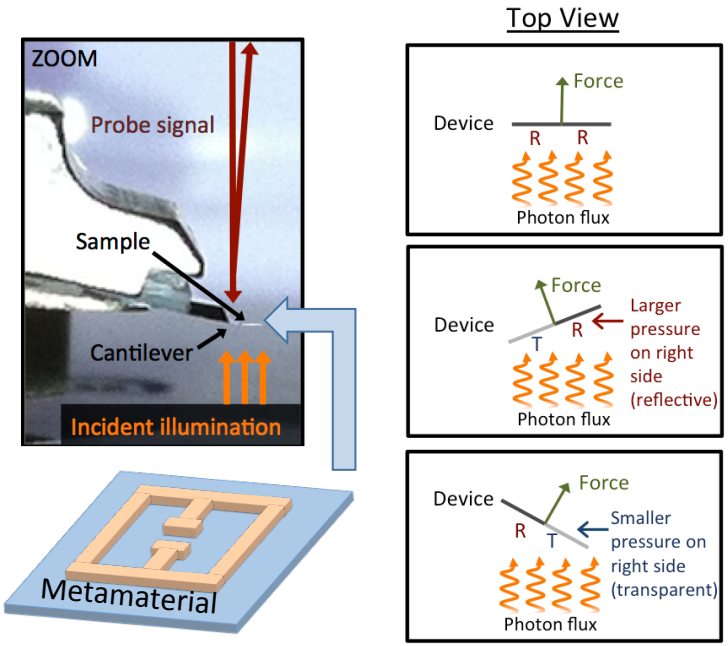

Figure. Left: Experimental setup to measure radiation forces based on an atomic force microscope. Lower panel shows a metamaterial, i.e. an optically engineered structure that is significantly smaller than the wavelength of light. Such structures can be designed to have a particular optical response. **Right:** Concept of steering without mechanical parts. By changing the optical reflectivity locally, a torque is exerted on the spacecraft causing it to turn.

Research objectives

-Determine the effect of radiation pressure on metals, dielectrics, and metamaterials to elucidate the role of photon momentum.
-Control of radiation pressure on materials by modulation of the reflectivity.

Summary

We will use an atomic force microscope-based technique to measure the radiation pressure exerted on materials with switchable reflectivity. This project will involve both the development and fabrication of unique metamaterials and the subsequent measurement of optical forces on these materials. Possible applications include lightweight structures for solar sail propulsion and steering.

Impact

Basic Science:
-Potential resolution to photon momentum controversies.
-Advance understanding of optically engineered materials.
NASA:
-New, lightweight structure concept for solar sails.
-New attitude control technique without mechanical motion.
-Development of a technique to measure photon radiation pressure to evaluate the performance of potential solar sail materials.